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Willingness to pay for mangrove restoration in the context of climate change in the Cat Ba biosphere reserve, Vietnam

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ABSTRACT

The Cat Ba Archipelago is an island chain bordering Hai Phong City in North Vietnam and has been recognized as a biosphere reserve by the United Nations Educational, Scientific and Cultural Organization (UNESCO) since 2004. However, the mangrove forest ecosystem of this reserve has suffered severe degradation due to its partial conversion to shrimp aquaculture. The restoration of the mangroves is expected to play an important role in dealing with climate change impacts, given their ability to mitigate the impact of tropical storms. This study examined the factors influencing the willingness to pay (WTP) for mangrove restoration in the context of climate change in the mangrove forest ecosystems of the Cat Ba Biosphere Reserve (CBBR), Vietnam. We employed a contingent valuation method to estimate household WTP for mangrove restoration, drawing upon data from a survey of 205 respondents in four villages in the buffer and transition zones of the biosphere reserve where mangrove forests are found. The mean WTP is estimated to be 192,780 VND (US$8.64), while the total annual benefit from the mangrove conservation programs of the CBBR is estimated at 712.3 million VND (US$31,943). The results revealed that gender, education level, occupation, the participation of respondents in mangrove restoration activities, and their attitudes toward the impact of climate change were significant factors in their WTP for mangrove restoration. Since mangroves can significantly contribute to mitigating climate change impacts by easing the effect of tropical storms and protecting dyke systems, the local government of Hai Phong City should implement the necessary regulations and policies to conserve the mangrove forests of the Biosphere Reserve.

1. Introduction

Mangrove forests, which appear in the inter-tidal zones along the coasts in tropical and semi-tropical regions, are considered as one of the most important ecosystems on the Earth (Edward and Suthawan, 2004). Mangrove ecosystems can act as highly efficient carbon sinks in tropical climates (Donato et al., 2011) because they can sequester carbon in both aboveground biomass (Pham et al., 2018c) and below-ground biomass (Pham and Yoshino, 2017; Pham et al., 2017), as well as in sediments (Alongi, 2012; Kauffman et al., 2013). Despite such benefits, many mangrove forests have been lost in the past 50 years worldwide due to high population growth, rapid urbanization, aquaculture expansion and the impact of other human activities (Alongi, 2002; Chen et al., 2017; Giri et al., 2015). Among the regions of the world, Asia has suffered the greatest loss (1.9 million hectares) of mangroves (FAO, 2007), with more than 100,000 ha being lost from 2000 to 2012 (Richards and Friess, 2016). Like many other countries in Southeast Asia, the mangrove forests of Vietnam declined dramatically by 400,000 ha in the early 20th century (Tuan et al., 2003), and are still under severe threat due to high population growth, aquaculture expansion, and migration into coastal areas. For example, the mangrove areas of the northern coast of Vietnam decreased by 17,094 ha between 1964 and 1997. This loss of mangrove forests was due to over-expansion of shrimp aquaculture (Pham and Yoshino, 2016; Quoc Vo et al.,

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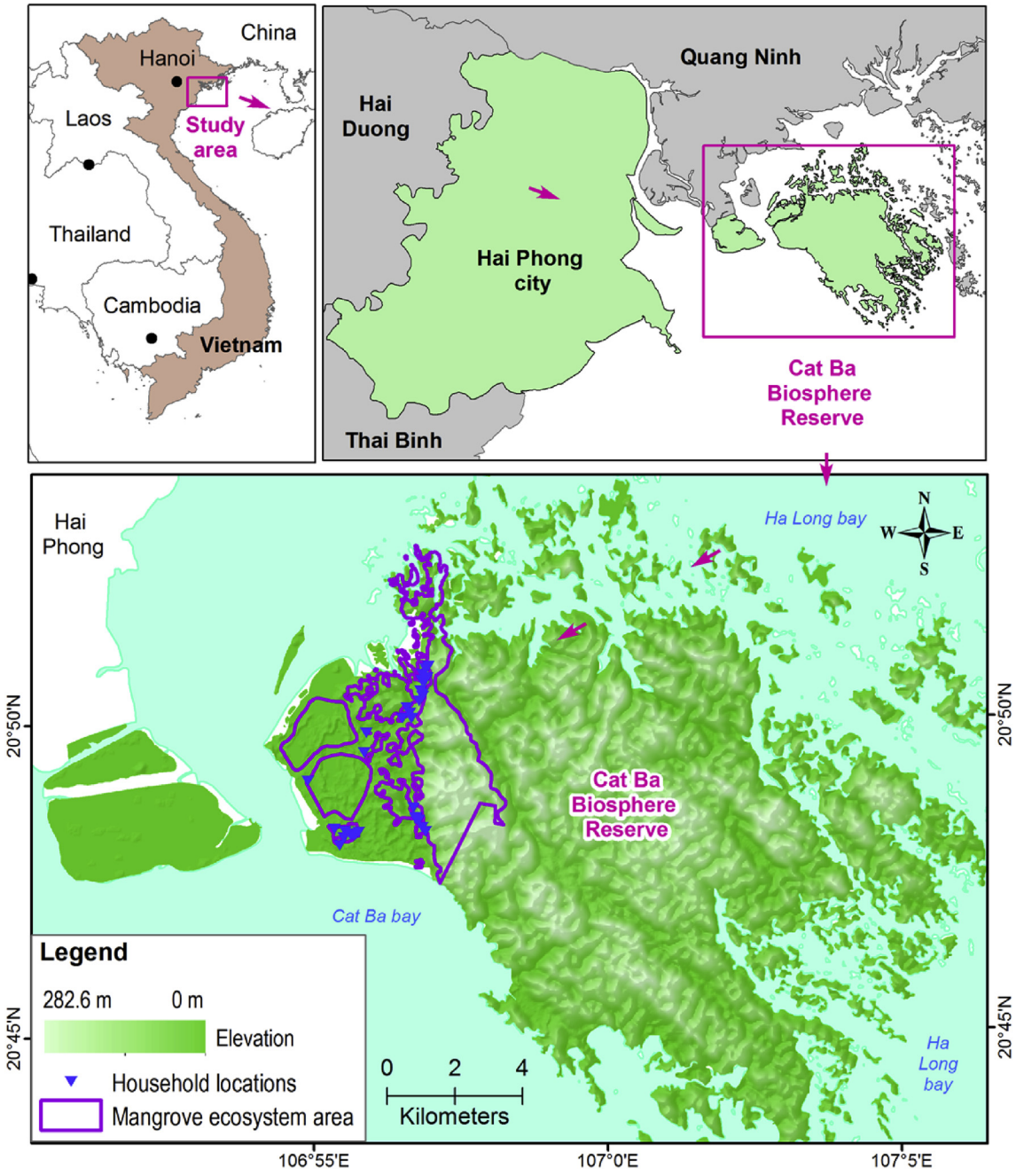

Fig. 1. The study area of the Cat Ba Biosphere Reserve, Vietnam.

2015; Vo et al., 2013).

One of the essential steps for planning and implementing restoration and conservation programs in mangrove forests, apart from quantitatively identifying such losses, is to know the economic value of the loss, and the social benefits of restoring the lost resource. The economic valuation of ecosystem services has become more prevalent during the last few decades (Barbier et al., 1997; Brouwer et al., 2016; Ekka and Pandit, 2012; Gunawardena and Rowan, 2005; Ninan and Kontoleon, 2016). However, only a few studies have attempted to value mangrove ecosystem services, and to measure the willingness to pay (WTP) to restore the perceived benefits of mangroves in the coastal zone. Previous studies are limited to specific regions in India (Stone et al., 2008) and Indonesia (Susilo et al., 2017a). Stone et al. (2008) indicated that the perceived benefits of mangrove restoration are the most significant factor influencing local households' WTP among the fishing communities and rice farmers in the mangrove ecosystems found on the west coast of India. A more recent study of the Mahakam Delta mangroves in Indonesia by Susilo et al. (2017a) showed that the mean WTP estimated using contingent valuation was IDR 35,201 (US$2.71). This study also reported that over 80% of the respondents considered the perceived benefits of mangroves for their livelihood. Nevertheless, these previous studies did not consider the climate change impacts that may affect the success of mangrove restoration projects. As mangroves can significantly contribute to mitigating climate change impacts and protecting dyke systems in the coastal zones, mangrove restoration projects should carefully take this role into consideration (Lewis, 2009).

There are a limited number of studies that have estimated WTP for natural resources conservation, and/or respondents' perceptional factors influencing their WTP in Vietnam. Existing studies are restricted to specific regions, such as in marine protected areas (Kaida and Dang, 2014), or mangrove forests in South Central Vietnam (Tuan et al., 2014). Kaida and Dang (2014) estimated that the mean visitor WTP for

conservation programs in the Nha Trang Bay Marine Protected Area in Vietnam was about US$5.99, and reported that income and education of respondents are correlated with their WTP. Recently, Tuan et al. (2014) estimated that the mean household WTP for mangrove restoration in a lagoon in South Central Vietnam was around VND 131,670. They indicated that housing condition and attitude of respondents on the future climate scenario are significant factors influencing household WTP. However, most of the socioeconomic and perceptional factors were not significantly influenced by the WTP of respondents in these studies. Since mangrove forest restoration and conservation in Vietnam are substantially influenced by the livelihoods available to local communities (i.e., the growing expansion of shrimp aquaculture in mangrove forest areas), and their perceptions toward conservation activities, it is also crucial in policy planning and implementation to identify the socio-demographic and perceptional factors that could affect their WTP for conservation programs.

Our review of current literature shows that this is the first study that has attempted to estimate respondent WTPs and to examine the perceptions influencing their willingness to pay for mangrove restoration in a Biosphere Reserve in Vietnam. However, given that the economic valuation of mangrove ecosystem services in the study area can now be established, the present study is able to promote the implementation of mangrove conservation and restoration strategies in climate change mitigation approaches such as the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD +) program. It also provides significant comment regarding Payment for Ecosystem Services (PES) for developing regional and national blue carbon trading markets, and for guiding mangrove management and conservation for Blue Carbon projects (Ahmed and Glaser, 2016; Pendleton et al., 2012).

Thus, the main objectives of the present study were to estimate the WTP for mangrove forest restoration within those households who interact with mangrove forests for their livelihood and who will have to deal with climate change, and to examine socio-demographic and perceptional factors influencing household WTP for mangrove conservation programs. The present study focused on the payment for sustainable mangrove ecosystem conservation and management in the Cat Ba Biosphere Reserve (CBBR) (buffer and transition zones) located on the northern coast of Vietnam.

2. Background of the mangrove ecosystem of the Cat Ba biosphere reserve

Cat Ba is the largest island in the Cat Ba Archipelago in Hai Phong City, located in the north of Vietnam (Fig. 1). The core ecosystem of the island is tropical forest including tropical rainforests in the lowlands, limestone forests in the mountains, and mangrove forests along the coast. Cat Ba Island has been recognized by UNESCO as a biosphere reserve since 2004. The total area of the CBBR is about 26,241 ha and the total population in 2015 was 18,475 persons, or 3695 households (Hai Phong Statistical Office, 2015). The biosphere is a well-known destination for tourists from not only all parts of Vietnam, but also from around the world. The number of tourists has significantly increased over the last decade (Mai and Smith, 2015), and is now about 500,000 annually (Le Viet et al., 2015).

Despite the continuing large growth potential in tourism, the CBBR is under serious threat from the degradation of its forest environments. From 1990 to 2001 the tropical rainforest of the CBBR declined by roughly 660 ha, equaling 4.5% of the total area, while the mangrove forest decreased by almost 600 ha, or about 50% of its original coverage (Hoang and Lin, 2001). The mangrove forest area in the reserve declined largely due to the over-expansion of shrimp aquaculture, which added a further 627 ha in 2015 (Pham et al., 2018a,b; Pham and Yoshino, 2016). In addition, the marine ecosystem is being polluted at an alarming rate because of the solid and sewage wastes generated from tourism and intensive aquaculture activities, as well as from domestic and industrial activity. Consequently, a large number of environmental parameters, such as the biological and chemical oxygen demand of the marine ecosystem, do not meet national standards (Son et al., 1999).

In addition to the biophysical impacts of tourism growth and aquaculture activities, poverty is still persistent within the CBBR. The incidence of poverty in the reserve is still high and around 40% of the population in the CBBR lives in the rural area, where the average annual net income per capita was as low as 4875 million VND in 2010 (equivalent to US$325 or US$0.89 per capita per day) (Nguyen and Bosch, 2013). The net income in some villages located in the buffer and transition zones of the CBBR, such as Viet Hai and Hien Hao, is even lower at US$0.56 and US$0.64 per capita per day respectively. These numbers are far lower than the poverty level of US$1.25 per capita per day set by the United Nation poverty indicator (World Bank, 2012). Furthermore, many of the rural citizens of Cat Ba Island living in poverty do not benefit from the shrimp aquaculture activities or tourism. The vast majority of the wealth generated by tourism and aquaculture on the island is instead appropriated by international tourism agencies, hotel operators, and private companies.

The forest and environmental degradation and persistent poverty occurring on Cat Ba Island are clear indications that, although the tourism and aquaculture sectors are growing rapidly and are the largest contributors to the local economy, they are far from being sustainable (Mai and Smith, 2015). In addition, the increasing demand for seafood from a rapidly growing tourism, and the poorly regulated international and domestic markets are exacerbating pressures on the marine ecosystem, especially on the mangrove forests, with further devastating consequences to the local livelihoods that they support.

Over 95% of the mangroves in the CBBR are found in the Phu Long commune, a community with 595 households. Mangroves of the CBBR are not located on the tourism sites, therefore, very few tourists visit the mangroves forests of the CBBR. There are a total of four villages in Phu Long where mangrove forests are found in the buffer and transitional zones to the CBBR (Hai Phong Statistical Office, 2015; Pham et al., 2018b). Three villages are in the transitional zone: Ngoai, Bac, and Nam, while Ao Coi is in the buffer zone. According to the survey carried out in September 2016 for this study, the socio-economic characteristics of these villages were significantly different. In the transitional zone, households are likely to be involved in the aquaculture sector as they have their own shrimp ponds. Conversely, farming and hired labor are the main occupations in Ao Coi as they do not have their own ponds.

3. Method

3.1. The Contingent Valuation Method

The Contingent Valuation Method (CVM) is widely used to estimate community willingness to pay (WTP) for environmental conservation and ecosystem services (Alves et al., 2015; Brouwer et al., 2016; Susilo et al., 2017a; Trujillo et al., 2016; Zhang et al., 2011). CVM is a survey-based approach, in which an individual independently states his or her willingness to pay (WTP) for the conservation of environmental services in a particular location (Mitchell and Carson, 1989). There are two main kinds of willingness to pay (WTP) questions: direct or open-ended, and dichotomous choice. The latter was employed in this study; a single-bounded dichotomous choice WTP question was used, incorporating five bids. Dichotomous choice (DC) questions help avoid some biases in answers (such as outliers) but require complicated statistical treatment (Cooper and Loomis, 1992).

In this study, CVM was employed to estimate the WTP for the restoration of the mangrove forest in the CBBR (Mitchell and Carson, 1989). The DC consists of two formulas: a single-bound (SB) model which offers one question as to whether a bid is “accepted” or “rejected,” and a double-bound (DB) model which presents two bids to a respondent. The respondent who has accepted the first bid is offered a higher bid in a second round and the one that has rejected it is offered a lower bid. The DB model has been widely used because the additional

information provides clearer bounds for the respondent in determining their WTP. However, several studies have pointed out that the DB format can induce some biases and inconsistencies through the existence of bound effects (Bateman et al., 2001; Carson et al., 2001; McFadden, 1994). To avoid these potential problems, a single-bound dichotomous choice (SBDC) model was considered the appropriate empirical analysis method to determine household WTP in this study.

The two most popular forms of the SB are the logistic function, which is used in logit estimation, and the cumulative normal distribution, which is used in probit estimation. When determining which model to use in this study, logit and probit analyses yielded similar marginal effects in most applications, and the outcomes were similar (Haab and McConnell, 2002). In this study, a logit regression model was used to determine household WTP. The formula of this model is as follows:

$$\Pr(\text{Yesj}) = \frac{1}{1 + \exp\{-(\alpha - \beta \cdot BID + \gamma \cdot \chi)\}} \quad (1)$$

where α is constant, β is the coefficient of the BID as restoration fee, χ is the vector of explanatory variables influencing the response, and γ is the vector of the corresponding parameters.

Parametric estimation: the parametric method was used to estimate the WTP by using logit regression; in which the dependent variables are the household saying 'yes' to pay for t_i, or 'no' to payment for the t*i* bid level. The list of explanatory or independent variables was subjected to a regression analysis, which was used to estimate the effect of each variable to the WTP of each household including bid amount, the socio-economic characteristics, the participation of respondents in mangrove restoration activities, and the attitude of respondents towards the restoration of mangroves:

$$\alpha_1 Z_j + \beta(Y_j - T_j) + \varepsilon_{1j} = \alpha_0 Z_j + \varepsilon Y_j + \varepsilon_{0j}$$

Therefore, the mean WTP is calculated using equation (2):

$$\text{Mean WTP} = E(\text{WTP}|\, \alpha_1, \beta, z_j) = \alpha_1 z_{jx}\, \beta^{-1} \quad (2)$$

We estimated respondent WTP based on a *yes* or *no* answer to each of the SBDC questions at five different sets of bidding prices. If she/he accepted a bidding price for the single-bounded question, the model can be depicted in a linear or logistic form (Cooper and Loomis, 1992). In this study, we analyzed which variables (factors) would promote respondent WTP for mangrove restoration using a binary logistic regression model. The dependent variable indicating the willingness of respondents to pay for mangrove restoration had binary values of 0 and 1, where 0 denotes unwillingness and 1 reflects willingness to pay. There were five bid levels ranging from 20,000 VND to 300,000 VND per household per year. The variables used in the logit regression model are shown in Table 1.

Place of residence, gender, age, marital status, income, occupation, the number of household members, house type, and education level were considered as potential explanatory variables. Other variables, including the awareness of the respondents in relation to the perceived benefits of mangrove resources, attitude to the impacts from climate change, and the perceived importance of the mangrove forest restoration programs were also used in the model as perception factors that potentially influence WTP. All statistical analyses were performed using Stata 14 software (Stata Corp).

Regarding the occupation variable, we used dummy variables (binary values of 0 and 1) to examine whether aquaculture influences WTP for mangrove restoration, as the degradation of the mangrove forests in North Vietnam has resulted largely from the over-expansion of shrimp aquaculture (Pham and Yoshino, 2016). For this purpose, aquaculture was given a value of 1, while other occupations had a value of 0. As a place of residence, we assumed that the different locations of households might influence their WTP for mangrove restoration, as they would have different perceived benefits in relation to the mangroves resources, different attitudes to the impact of climate change, and differences in their perceived importance of the mangrove forest restoration programs. Thus, the respondents of the village in the buffer zone were given a value of 1, while three villages in the transitional zone of the CBBR were given a value of 0 (See Fig. 1).

Table 1
Description of variables used in the Logit Regression Model.

	Variables	Definition	Measurement/unit
1	Probability	The probability of a respondent being willing to pay for mangrove forest restoration	1 = Yes WTP 0 = No WTP
2	Bid	Bid levels (1000 VND)[a]	20, 50, 100, 200, 300
3	Age	Age of respondent	Numeric variables
4	Gender	Gender of respondent	1 = Male 0 = Female
5	HH size	Number of family members	Numeric variables
6	Education	If respondent was educated to high-school level or above	1 = High school and above 0 = Otherwise
7	Housetype	The house type of respondent	1 = Permanent house 2 = Otherwise
8	Occupation	Occupation of respondent (main income source)	1 = Aquaculture 0 = Otherwise
9	Zone	Place of residence	1 = Buffer zone 0 = Transitional zone
10	Lnincome	Natural logarithm of total household income per month (million VND)	Numeric variables
11	Severe	Respondent attitudes toward the impacts of climate change	1 = Very severe 0 = Otherwise
12	Agreecons	Respondent's decision on mangrove restoration	1 = Strongly agree; 2 = Agree; 3 = No opinion; 4 = Disagree; 5 = Strongly disagree
13	Information	Respondent's knowledge about climate change and its adverse impact on mangrove restoration and the community	1 = Very new information 2 = Knew some news 3 = Knew all
14	Volunteer	Respondent's desire to participate in mangrove restoration activities	1 = Want to join 0 = Otherwise

[a] US$1 is equivalent to VND 22,300.

3.2. Questionnaire design and survey method

The questionnaire in the present study was predesigned, and was revised based on key informant interviews with the village heads of the four studied communes, the chairmen of farmers' associations (a total of 11 interviewees), and a focus group discussion with the representatives of environmental managers and the village heads of the four communes in the study area. Based on the information exchanged during these sessions, we carefully developed multiple scenarios for the restoration project and the proposed conservation fees as bids for the questionnaire survey, so that these were understood and accepted by the respondents.

The main survey was conducted in September 2016. A total of 205 household responses were collected and all of which were usable. The scenarios such as promoting mangrove planting and restoration activities, preventing illegal logging of mangroves introduced to the respondents for the restoration project in order to deal with climate change impacts were developed based on the current situation of mangrove ecosystem of the CBBR for a restoration project. The payment vehicle chosen for the survey was conservation fee for a mangrove restoration project which applied to all households living in the CBBR. This is familiar to respondents, as it is similar to the sanitary fee. Given that conservation fee is charged to households, it is suitable to survey on behalf of each household.

All respondents were asked to answer the questionnaire, which consisted of four main parts by face-to-face interviews. In the first part, respondents were asked general information on the socio-economic

characteristics of their households. In the second part, general information on the mangrove ecosystem services of the CBBR was given to the respondents who lived in the four villages located in the buffer and transitions zones of the reserve. They were then asked the reasons for mangrove conservation and protection in the CBBR, and the perceived benefits of mangrove ecosystems for their livelihoods. As a mangrove ecosystem has numerous ecological functions and plays an important role in local livelihoods, mangrove rehabilitation and restoration actions are expected to help the local communities in dealing with climate change in Vietnam (Powell et al., 2011). The second section in the questionnaire thus revealed respondent assessments of the proposed mangrove restoration programs and their awareness of these programs.

In the third part, the current situation of mangrove ecosystems in the context of climate change issues and the problems associated with management of the mangrove resource were made known to the respondents. They were then asked to rate the current conservation scenarios for the mangrove ecosystem in the study site. First, the current status of the mangroves was introduced, reflecting the fact that these forests have decreased due to the rapid increase of extensive shrimp aquaculture. Secondly, the impacts from climate change and predicted sea level rise were also provided to all respondents. They were then asked to evaluate the levels of seriousness of the current conservation scenarios of mangrove ecosystems in the CBBR. Information on the awareness of local people about mangrove restoration under the context of climate change was explored to help respondents understand the agreement levels and motivation for the WTP for mangrove restoration in the CBBR. Respondents were then asked about their opinions on mangrove restoration since the mangrove ecosystem is expected to provide both direct and indirect benefits for local communities (Kuenzer et al., 2011).

The last part of the questionnaire explored the WTP of respondents for mangrove restoration in the context of the climate change issue. The respondents were asked whether they agree/disagree with the paying for mangrove restoration and to explain the main reasons for their decision. Respondents were also asked about their motivations in relation to mangrove restoration and conservation activities. This involved them giving an answer on the perceived benefits of mangrove forests, and the main reasons for mangrove restoration under the context of climate change. It is noted that a respondent who answered yes/no for his/her WTP also gave a reason for agreeing/not agreeing.

To determine a statistically visible sample sine for the CVM in this study, we applied equation (3) to select the total number of households:

$$n = \frac{N}{1 + Ne^2}. \quad (3)$$

where n is a sample size, N is a total number of HHs in the areas, and e is desired margin of errors.

According to the Statistical department of Hai Phong city in 2015, there are about 2975 people corresponding to 595 HHs (average HHs size of 5 persons) of Phu Long commune located on the buffer and transition zones of the Cat Ba Biosphere Reserve. With a designed margin error of 6%, a total minimum sample size of 189 HHs was planned to be sampled in the survey. Finally, a total number of 205 respondents randomly selected from four villages of Phu Long commune, were interviewed and all of which were usable in the model.

4. Results

4.1. Socio-demographic characteristics of the respondents

The socio-demographic characteristics of the respondents are shown in Table 2. Gender balance was carefully taken into consideration in data collection; thus, we attempted to interview equal numbers of males and females. However, the eventual number of male participants (63% of the 205 respondents) was larger than the number of females. This over representation of males in the present sample reflects the fact that, in general, men tend to be the family representative and are responsible for economic decision-making. This is especially so in relation to the use of the mangrove forests and in aquaculture, which they are substantially engaged in. In the case of the northern coast of Vietnam, the money income of a household is in general contributed mainly by men (husbands), while women (wives) are often responsible for taking care of housework and teaching their children.

Table 2
Socio-demographic characteristics of the respondents.

	Category	Frequency	Percentage
Gender	Male	130	63.41
	Female	75	36.59
Age (years old)	18–25	3	1.46
	26–35	18	8.78
	36–45	38	18.54
	46–55	61	29.76
	≥56	85	41.46
Education	Under primary school	2	0.98
	Primary school	34	16.59
	Secondary school	109	53.17
	High school	38	18.54
	Technical school	10	4.88
	University	5	2.44
	Post graduate	1	0.49
	Illiterate	6	2.93
Occupation	Aquaculture sector	60	29.27
	Fisherman	37	18.05
	Business owner	34	16.59
	Hired labor	28	13.66
	Farmer	15	7.32
	Retired	17	8.29
	Government Officer	5	2.44
	Disabled	5	2.44
	Babysitter	3	1.46
	Student	1	0.49
House type	Permanent house	120	58.54
	Semi-permanent house	85	41.46
	Temporary house	0	0
Household size (persons)	1	5	2.44
	2	46	22.44
	3	37	18.05
	4	50	24.39
	5	42	20.49
	6	18	8.78
	7	4	1.95
	8	3	1.46
Income (1000 VND)	< 1000	13	6.34
	1100–3000	54	26.34
	3100–6000	75	36.59
	6100–9000	25	12.19
	> 9000	38	18.54

The age distribution of respondents in the present sample shows they are predominantly aged over 45; this group accounted for over 70% of the total sample. This reflects the local situation that the middle-aged and elderly tend to work in their villages, while younger people (below 45) tend to work outside. Our respondents generally had low educational levels: about 70% of them had completed secondary school or lower, followed by high school (18.5%), and higher education (less than 10%). Approximately 3% of the respondents were illiterate.

In this study, respondent occupations fell into four categories: working in the aquaculture sector, in fishing, as business owners, or as hired labor; and these four accounted for 78% of the total sample. The remainder were government officers, retirees, farmers, and others. Nearly 50% of the respondents had aquaculture work experience (owning shrimp farms, fishing, employees at private aquaculture companies, and so on). This indicates that the study sample represents typical coastal communes in North Vietnam, where local livelihoods mainly rely on aquaculture activities.

For house types, there was no respondent that lived in a temporary

Table 3
The importance of the mangrove ecosystem functions in the Cat Ba biosphere reserve.

Mangrove ecosystem function	Ao Coi	Bac	Nam	Ngoai
Unknown	2.8	1.6	0.0	0.0
Improve the sustainability of local livelihoods	11.1	18.0	7.4	2.5
Supporting services	2.8	0.0	0.0	4.9
Provisioning services	11.1	3.3	11.1	6.2
Regulating services	69.4	75.4	77.8	85.2
Help protect biodiversity	0.0	1.6	3.7	1.2
Opportunities and benefits for future generations	2.8	0.0	0.0	0.0

Note: values are percentage of total individual responses.

house in the study area because the Vietnamese Government has attempted to remove slums and temporary housing. About 58% of the respondents had a permanent house, while the rest had a semi-permanent house. Average household size in the sample was 3.79 persons, which is equivalent to the normal family size in Hai Phong City (3.95) (Hai Phong Statistical Office, 2015). Over one-third of the respondents (37%) had a monthly household income of between 3.1 and 6.0 million VND (about 140–270 US$), followed by 31% receiving more than 6.1 million VND (about 280 US$), and 25% were in the range between 1.1 and 3 million VND (about 49.5–139 US$). About 6.3% are likely to be poor households, similar to the poverty rate for Hai Phong City, with incomes lower than the poverty level set by the UN poverty indicator (1.25$ per capita per day) (World Bank, 2012).

4.2. Perceived benefits of mangroves in the Cat Ba biosphere reserve

Table 3 shows the responses of respondents in the buffer and transitional zones of the CBBR in terms of the importance of the mangrove ecosystem functions associated with their livelihoods. The results reveal that over 69% of respondents understand the function of mangroves as regulating services in storm prevention, pollution reduction, flood and erosion control, and in carbon storage. In addition, 2.5–18.0% of respondents positively assessed the benefits of mangroves for improving the sustainability of their livelihoods. However, 1.6–2.8% of respondents did not understand the importance of mangrove ecosystem functions.

Table 4 shows that many in the four villages believe that the mangrove ecosystems of the CBBR are under very severe stress, ranging from 25% to over 45% of the total respondents. The percentage of respondents in the four villages who consider that the mangrove ecosystems are under severe stress is over 33%, except for the respondents from Ngoai village. In contrast, approximately 42% of the respondents from Ngoai village feel that the current stress on the local mangrove ecosystem is not so severe, while this opinion was held by between 21 and 33% of the respondents from the other three villages. Overall, the results show that respondents realize that the mangrove ecosystems in the study area have been exposed to destruction through deforestation and biodiversity loss.

Table 4
The Stress on Current Mangrove Ecosystems in the Ao Coi, Bac, Nam, and Ngoai villages.

Household opinion	Ao Coi	Bac	Nam	Ngoai
Very severe	45.7	24.6	29.6	30.6
Severe	33.3	49.2	33.3	16.7
Not so severe	21.0	21.3	33.3	41.7
Not at all	0.0	4.9	3.7	11.1

Note: values are percentage of total individual responses.

Table 5
Distribution of responses by bid amount.

Bid level (VND)	Number of respondents	Number of "Yes" votes	Share of "Yes" votes Percent
20,000	41	36	87.8
50,000	41	39	95.1
100,000	41	30	73.2
200,000	41	33	80.5
300,000	41	26	63.4
Total	205	164	

Note: US$1 was equivalent to VND 22,300 at the time of the study.

4.3. Bid response

Table 5 summarizes the WTP bids and the total number of respondents and their responses within a given bid level corresponding to those levels. The proportion of 'yes' votes to the base bid (BD) ranged from 87.8% for VND 20,000–63.4% for VND 300,000.

4.4. WTP estimates

The regression results are shown in Table 6. The bid variable was found to be significant with a negative coefficient (Coef = −0.006, $p = 0.004$, $t = -2.890$), indicating that the likelihood of answering yes decreases as the bid is raised. The mean WTP was estimated at 192,780 VND (US$ 8.64), while the median was 134,000 VND. There was a significant positive correlation between respondent occupation and WTP for mangrove restoration (Coef = 1.456, $p = 0.011$, $t = 2.530$), reflecting that involvement in aquaculture could influence the WTP of respondents for mangrove restoration.

The attitude of respondents to the future climate change scenario was found to have a significant positive influence on respondent WTP for mangrove restoration (Coef = 1.064, $p = 0.037$, $t = 2.080$), implying that awareness of the likely severity of future climate scenarios leads to a respondent being willing to pay more. In contrast, there was a negative significant correlation between gender and WTP at 5 percent (Coef = −0.976, $p = 0.042$, $t = -2.040$), reflecting that men were likely to pay less for mangrove restoration programs. The regression results also indicate that volunteer experience had a positive influence in explaining WTP (Coef = 0.387, $p = 0.020$, $t = 2.330$), showing that respondents were likely to participate in mangrove restoration programs. In addition, educational level was found positively related to WTP (Coef = 0.932, $p = 0.098$, $t = 1.660$).

Finally, the total value from the restoration of the mangrove

Table 6
Determinants of the WTP for mangrove restoration.

Variables	Coefficient	Std. error	t - value
Constant	1.112	1.519	0.730
Bid	−0.006***	0.002	−2.890
Age	0.022	0.016	1.410
Gender	−0.976**	0.479	−2.040
HH size	−0.152	0.138	−1.100
Education	0.932*	0.563	1.660
House type	0.404	0.437	0.920
Occupation	1.456**	0.574	2.530
Zone	−0.288	0.555	−0.520
Lnincome	0.088	0.054	1.610
Severe	1.064**	0.511	2.080
Agreecons	−0.259	0.431	−0.600
Information	−0.144	0.305	−0.470
Volunteer	0.387**	0.166	2.330
Log likelihood	−79.775		
Prob > chi 2	0.000		
Pseudo R^2	0.222		
Mean WTP (VND)	192,780		

Note: Significant at $p < 0.1$ (*), 0.05 (**), and 0.01 (***).

Table 7
Reasons for being willing to pay and for not being willing to pay.

	Percent
Respondent's reasons for being willing to pay	
I think the mangrove conservation program is a good case	28.6
I think amount of money to pay is reasonable	14.0
I am considered about the loss of biodiversity and mangroves in the CBBR	4.3
I am worried about flooding during stormy seasons	38.4
I always comply the community activities	7.4
I want to live in the fresh environment	3.0
I want to protect it for the next generations	1.3
I want the local people could aware environmental protection	2.5
I want to get the natural breeds	0.6
Total	100
Respondent's reasons for not being willing to pay	
I do not have the financial capability to pay	58.2
I think it is the government's responsibility	10.0
I think the users should pay	14.4
I believe that the situation will be better without my contribution	5.0
I do not care for the nature conservation issues in the area	2.5
I do not understand the question	7.5
I don't know/not applicable	2.5
Total	100

ecosystem in CBBR was calculated by multiplying mean WTP per household and the total number of households living in the CBBR in 2016. The total value was calculated at about VND 712.3 million, equivalent to about US$ 31,943 per year. The estimated annual benefits of mangrove restoration per hectare in the CBBR was VND 1.14 million.

4.5. WTP responses and reasons for willing and not willing to pay

Table 7 gives the main reasons for respondents' being willing or unwilling to pay. The most important reason for WTP for mangrove restoration was their worry about the protection from flooding during storm seasons (38.4%). In this context, they believe that mangrove restoration activities are a good protection program (28.6%), and that for this reason it is necessary to conserve the mangrove forests of the CBBR. About 14% of the respondents believed that payment by indicating the bid level set for a respondent is reasonable approach to mangrove restoration. On the other hand, the main reason for not being willing to pay for the restoration of mangroves was income constraints, accounting for 58.2% of the negative responses; followed by the claim that it is the responsibility of government to pay for mangrove restoration (10.0%). Five percent of the respondents did not agree to pay because they thought that the situation would be better without their contributions, and about 7.5% of respondents did not provide an answer because they did not understand the question.

4.6. Perceived benefits from mangrove ecosystem and restoration activities

Table 8 shows respondents' perceived benefits for local communities from mangrove ecosystems. Over 42% of respondents believed that the local communities have benefited from prevention of flooding, storms and soil erosion, as well as improving general environmental protection; reflecting that a predominant number of the respondents have realized the important roles of mangrove ecosystems in their livelihood. They also considered that mangrove forests help to sustain seafood resources for the locals.

The results reveal that residents clearly recognize the roles of mangrove forests in their lives as the local communities are currently vulnerable to tropical storms, which appear to be more frequent now due to the impact of climate change. These results are consistent with previous studies reported by Powell et al. (2011) and Tuan et al. (2014).

Table 9 shows that nearly 80% of total respondents agree that the most important reason for supporting conservation of the mangrove ecosystem in the CBBR is to provide a service that helps in regulating the impact of events such as storms and rising sea levels.

Table 8
Perceived benefits from mangrove forests.

Benefits from mangrove forest	Percent
1. No benefit	0.9
2. Don't know	0.9
3. Seafood provision	17.4
4. Income from selling seafood	11.3
5. Recreation	3.0
6. Forest products	2.6
7. Research/education	0.4
8. Habitat for wildlife	11.7
9. Flood and storm/soil erosion prevention/environmental protection	42.4
10. Benefit for next generation	5.9
11. Fresh air and harmonize climate	2.6
12. Protect ships, boats	0.9
Total	100

Table 9
Reasons for mangrove conservation activities.

Reason	Percent
Improve sustainable local livelihood	9.4
Provide services: Supporting services	2.5
Provide services: provisioning services	6.9
Provide services: regulating services	79.3
Help protect biodiversity	1.5
Provide opportunities and benefits for future generations	0.5
Total	100

5. Discussion and policy implications

According to the current literature, only a few studies have employed the Contingent Valuation Method to estimate willingness to pay for valuing mangrove forests as a non-market resource. More importantly, to the best of our knowledge, this is the first study that estimates local community WTP for mangrove restoration in relation to climate change in a biosphere reserve designated by UNESCO. In the present study, we carefully investigated whether and how socio-economic characteristics and the perceived importance of mangrove ecosystem services among local communities influences their WTP for mangrove restoration in the biosphere reserve. This research also attempted to examine the relationships between respondent attitudes toward future climate change scenarios and their WTP for mangrove restoration.

The findings revealed that men tend to be engaged in physical labor such as aquaculture activities and hired labor, while women tend to be engaged in other activities such as collecting mangrove forests resources and selling them in local markets. However, the dominant roles of men, together with their limited understanding of indirect costs in their income generation activities, i.e., the collection of mangrove resources, and mangrove conservation activities, have led to inappropriate decisions and made their family situation more severe, including the potential for increased debts and poverty. As a result, women are likely to be paid more because they realize the important roles of mangrove forests, and they also might be engaged in mangrove restoration more than men. The results of this study can give guidelines and policy recommendations for improving the local livelihoods of female-headed households, or households without men, through participation in conservation and management activities.

The results showed that occupation has significantly influenced on the WTP of respondents. This was consistent with a recent study conducted by Susilo et al. (2017a). However, our findings are different to those from the previous studies reported by Stone et al. (2008) and

Tuan et al. (2014), that found that the socio-economic characteristics of respondents in their studies were not significant factors influencing their WTP. This may be because they conducted their studies in relatively high population density areas associated with industrial activities. Our research was conducted in the biosphere reserve of Cat Ba Island, which enjoys a relatively low population density. The results of our study also indicated that education level was found to be significantly positively related to WTP. The respondents with higher education were likely to pay more for the mangrove conservation and to participate in mangrove restoration through mangrove plantation activities. This was consistent with most empirical results in the previous studies (Susilo et al., 2017b; Zhang et al., 2011; Zhu et al., 2016), showing that education plays an important role in households' participation decisions for mangrove or wetland restoration. In addition, the findings showed that those respondents who consider the impacts of climate change seriously are likely willing to pay more. Our findings play a crucial contribution to the awareness of local residents on climate change impacts is raised, making them willing to pay more for mangrove restoration. This finding was confirmed by Tuan et al. (2014). Our results also suggest that zone has no significant influence on households' WTP for mangrove restoration in the study area, reflecting that the local residents in buffer and transition zones in the study area seem to have the similar awareness on the impact of climate change and tend to protect mangroves as mangroves play a crucial role in climate change mitigation rather than income benefits derived from mangroves resources. Our findings are different from the results conducted in Ca Mau province and in the Can Gio Mangrove Biosphere Reserve located on South Vietnam reported by Quoc Vo et al. (2015) and Kuenzer and Tuan (2013), indicated that the locations where farmers utilize mangrove as an income sources, they want to protect the mangroves, while other locations such as aquaculture area, farmers don't really care about mangrove.

The results of current work indicated that households in the study area who clearly understand the future climate scenario is severe are willing to pay more for mangrove restoration. Therefore, communication policies for awareness raising should be implemented to make the local residents willing to contribute more for mangrove restoration. It can be seen as a vital contribution of this study for the valuation of mangrove ecosystems in the context of climate change. Further improved mangrove conservation and management for eco-tourism to attract more tourists should be encouraged.

As shown in Table 4, our results showed that the current situation of mangrove ecosystems in the CBBR is very severe while mangrove restoration can significantly contribute to the local livelihoods in reducing impacts of climate change, policymakers should take it into account to give priority for mangrove plantation activities in the study area. This also should be emphasized and paid more attention to the national long-term strategy to mitigate and prevent climate change impacts.

Interestingly, our findings suggest that the greater participation of local communities in mangrove restoration activities and enhancing their attitudes toward future climate scenarios, facilitated their appreciation of the mangrove restoration project and allowed them to contribute to the more appropriate economic valuation of mangrove ecosystems. The results confirm the importance of mangrove ecosystems for local communities in dealing with the impact of climate change and providing values not only for current and but also for future generations. Therefore, the mangrove ecosystem of the biosphere reserve must be restored and effectively managed in the context of climate change.

The residents believe that the mangrove restoration program would represent a potential household response to the climate change issue due to the significant roles of the mangrove ecosystem in their livelihoods, if the programs were to be implemented. The results were consistent with previous studies reported by Stone et al. (2008) and Tuan et al. (2014). The residents thus realize the important role of mangroves in both livelihoods and disaster risk mitigation. Mangrove restoration projects are expected to provide benefits and satisfaction for locals if they are implemented in the study sites. In 2015, a trial of 100 ha of the mixture mangrove of *R. stylosa* and *A. marina* was planted and attracted the involvement of many local community volunteers. The success of this recent trial shows the feasibility of community-based mangrove forest management. Thus, the local government may be able to develop full-scale restoration plans to implement similar plantations in different restoration sites in the CBBR; recruiting community volunteers' involvement.

The mean WTP value for the respondents within four villages of the CBBR was estimated at about 192,780 VND (US$8.64) per year and the total annual benefits were 712.3 million VND (US$31,943) for the villagers. Thus, the annual environmental benefits estimated in the present study were about 1,140,000 VND per ha, while financial support for mangrove conservation and management is set at 400,000 VND. Using these newly defined benefits, the biosphere reserve may be supported financially and technically more intensively by the government.

The main limitation of the current study is that estimated WTP is likely to have been overestimated due to the increase in the yes category from 100,000 VND to 200,000 VND shown in Table 5. It is noted that different bids should have been randomly assigned to respondents regardless of their income levels. Thus, a yes vote of about 5–10% yes is optimum for the highest bid. Nevertheless, despite the limitations caused by the present survey design, our findings may boost local livelihoods by assisting government to formulate better policies for sustainable mangrove conservation and management in the biosphere reserve.

This study also promotes the implementation of Payment for Ecosystem Services (PES) strategies as part of the United Nation's Reducing Emission from Deforestation and Forest Degradation (REDD +) program in developing countries, and thus provides support for developing regional and national “Blue Carbon” trading markets, and guiding mangrove management and conservation. Our work may also promote an increased awareness among local people on the role of mangrove restoration in the context of climate change issues, since mangrove forests are expected to contribute significantly to the reduction of climate change impacts. Through this work, local settlements can realize the requirements of a restoration plan for coexistence with natural resources, and avoid their degradation from their long-term use.

6. Conclusions

This study employed CVM to estimate the WTP for mangrove forest restoration and conservation in the CBBR (Vietnam) and to examine the factors influencing WTP in the context of climate change. The estimation using the survey data on the local villagers yielded a mean WTP at 192,780 VND (US$8.64), and 712.3 million VND (US$31,943) as the total annual benefit for the villagers in the specific study area. The findings show that gender, education level, occupation, the participation of respondents in mangrove restoration activities, and the attitude of respondents toward future climate scenarios were significant factors influencing willingness to pay and participation in the mangrove restoration project. As the residents are likely to want to be involved in mangrove restoration activities, the local government should consider restoration planning for suitable pilot sites in the mangrove ecosystem of the CBBR; which would in turn encourage the involvement of different stakeholders, and contribute to the ability of local communities to achieve sustainable mangrove conservation and management.

It is suggested that local government should consider the sites for restoration plans while central government should implement mangrove restoration programs (e.g. reforestation and afforestation) in the mangrove forests in the CBBR, based on our findings that the local residents are willing to participate in restoration activities, and that mangrove restoration projects are expected to contribute significantly to the ability of local communities to deal with the impact of climate

change.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ocecoaman.2018.07.005.

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